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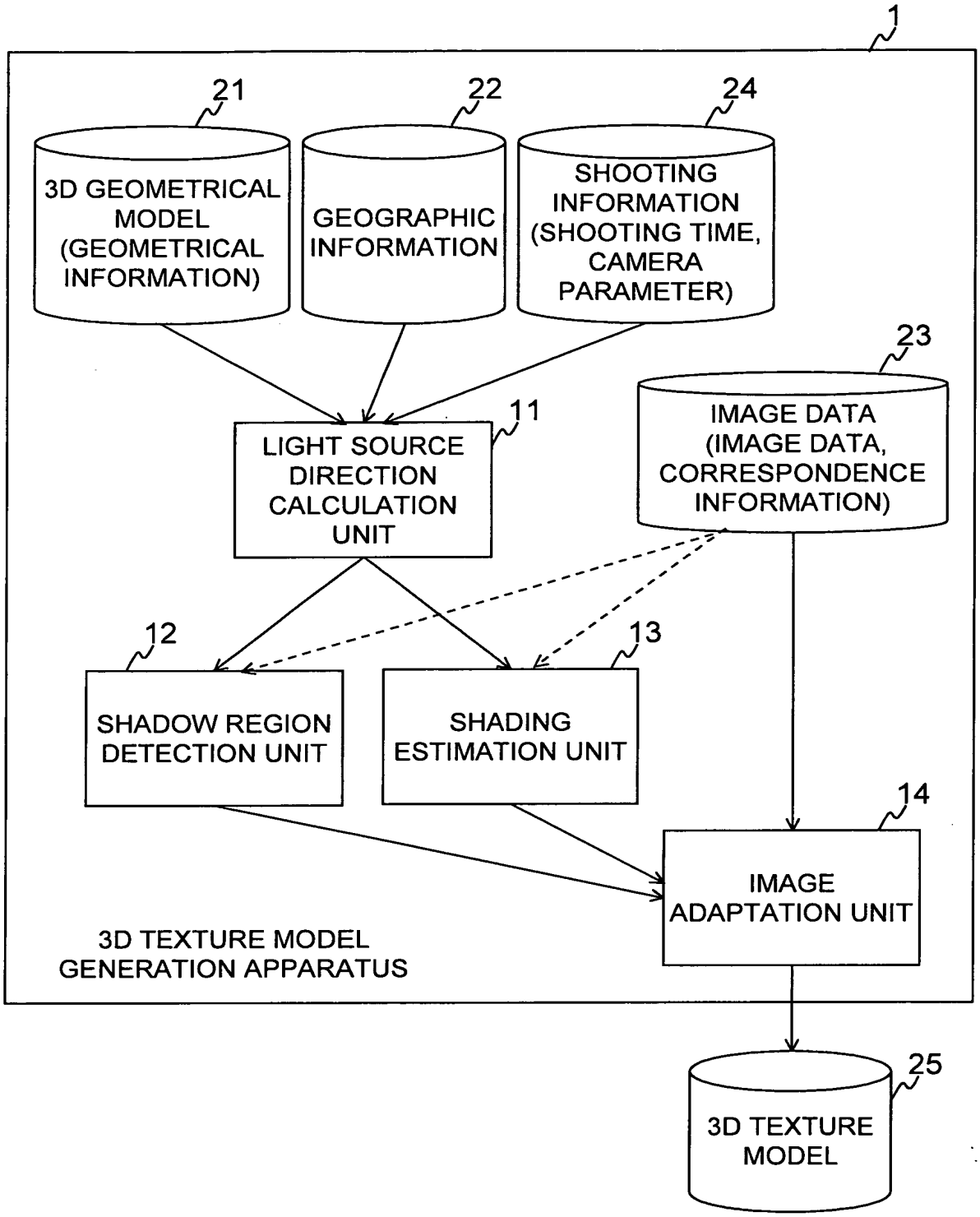
1
21
22
24
3D GEOMETRICAL MODEL (GEOMETRICAL INFORMATION)
GEOGRAPHIC INFORMATION
SHOOTING INFORMATION (SHOOTING TIME, CAMERA PARAMETER)
23
IMAGE DATA (IMAGE DATA, CORRESPONDENCE INFORMATION)
11
LIGHT SOURCE DIRECTION CALCULATION UNIT
12
13
SHADOW REGION DETECTION UNIT
SHADING ESTIMATION UNIT
14
IMAGE ADAPTATION UNIT
3D TEXTURE MODEL GENERATION APPARATUS
25
3D TEXTURE MODEL

FIG.1

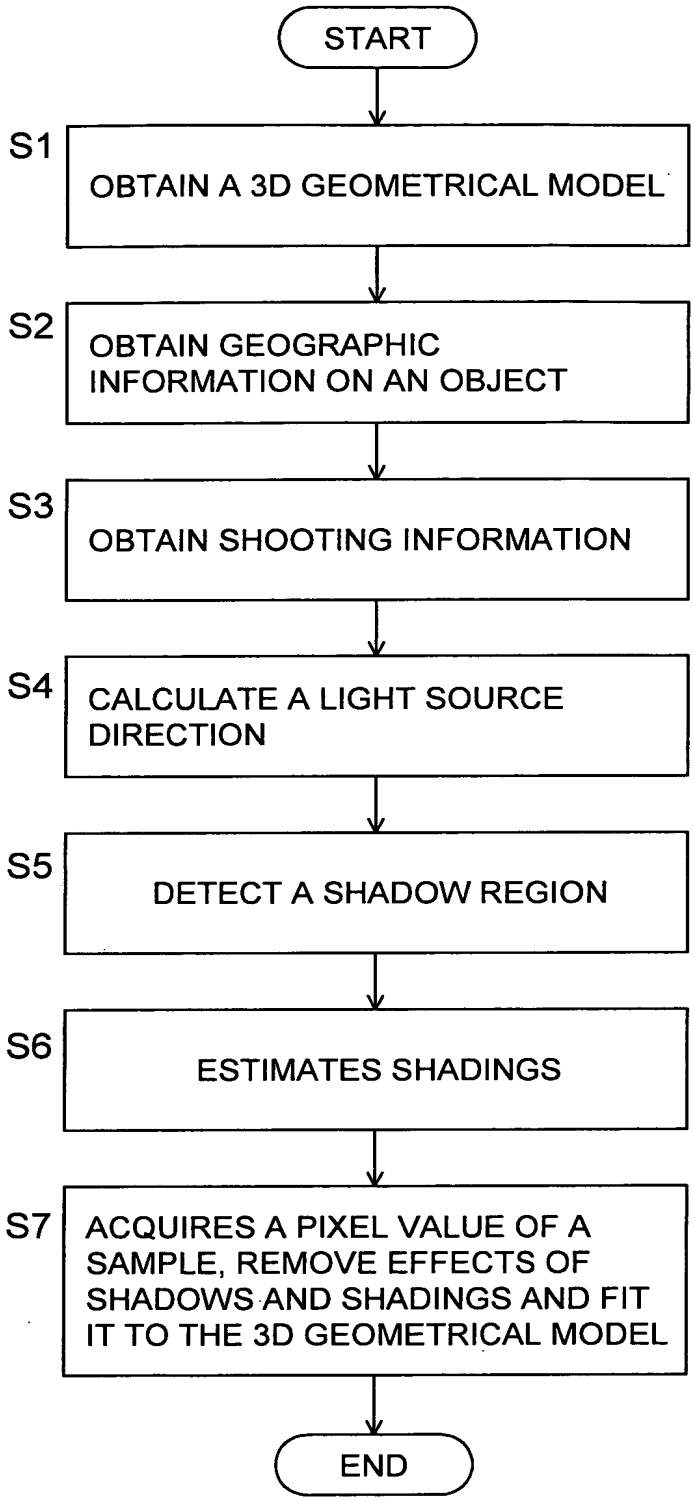
START
S1
OBTAIN A 3D GEOMETRICAL MODEL
S2
OBTAIN GEOGRAPHIC INFORMATION ON AN OBJECT
S3
OBTAIN SHOOTING INFORMATION
S4
CALCULATE A LIGHT SOURCE DIRECTION
S5
DETECT A SHADOW REGION
S6
ESTIMATES SHADINGS
S7
ACQUIRES A PIXEL VALUE OF A SAMPLE, REMOVE EFFECTS OF SHADOWS AND SHADINGS AND FIT IT TO THE 3D GEOMETRICAL MODEL
END

FIG.2

$$
\begin{aligned}
&\theta_d = 2\pi d / D_y, \\
&\theta_t = 2\pi t / T - \theta_{long}, \\
&A = \sqrt{\cos^2\theta_d \cos^2(\theta_{axis}) + \sin^2\theta_d}, \\
&B = |\cos^2\theta_d \sin^2\theta_{axis}| \\
&C = -A\cos\theta_t \\
&s_x = A\sin\theta_t \\
&s_y = YB\cos\theta_{lat} - C\sin\theta_{lat} \\
&s_z = B\sin\theta_{lat} + C\cos\theta_{lat}
\end{aligned}
\qquad (1)
$$

FIG.3

$$\alpha = \max(\cos^{-1}(l \cdot n), \cos^{-1}(v \cdot n))$$

$$\beta = \min(\cos^{-1}(l \cdot n), \cos^{-1}(v \cdot n))$$

$$v_\perp = v - n(n \cdot v)$$

$$l_\perp = l - n(n \cdot l)$$

$$\Delta_\perp = \begin{cases} 1 & \text{if } \|v_\perp\|\|l_\perp\| = 0 \\ \dfrac{(v_\perp \cdot l_\perp)}{\|v_\perp\|\|l_\perp\|} & \text{otherwise} \end{cases}$$

$$C_1 = 1 - \frac{\sigma^2}{2(\sigma^2 + 0.33)}$$

$$C_2 = \begin{cases} \dfrac{0.45\sigma^2}{\sigma^2 + 0.09}\sin\alpha & \text{if } \Delta_\perp \geq 0 \\ \dfrac{0.45\sigma^2}{\sigma^2 + 0.09}\left(\sin\alpha - (\dfrac{2\beta}{\pi})^3\right) & \text{otherwise} \end{cases}$$

$$C_3 = \frac{0.125\sigma^2}{\sigma^2 + 0.09}\left(\frac{4\alpha\beta}{\pi^2}\right)^2$$

$$f_1 = \frac{\rho}{\pi}\left[C_1 + C_2\Delta_\perp \tan\beta + \left\{(1 - \left|\Delta_\perp C_3 \tan\left(\frac{\alpha+\beta}{2}\right)\right|\right\}\right]$$

$$f_2 = \frac{0.17\rho^2}{\pi}\left[\frac{\sigma^2}{\sigma^2 + 0.13}\left\{1 - \Delta_\perp\left(\frac{2\beta}{\pi}\right)\right\}\right]$$

$$f(\sigma, \rho) = f_1(\sigma, \rho) + f_2(\sigma, \rho) \qquad (2)$$

FIG.4

$$I^c(p) = M^c(p)L_d^c\left\{K^{\#}(p,\sigma,\rho) + K_e^c\right\}$$
$$B_d^c(p)\left\{K^{\#}(p,\sigma,\rho) + K_e^c\right\} \quad (4)$$

where

$$K^{\#}(p,\sigma,\rho) = \begin{cases} 0 & \text{if } p \in R_S \vee (l \cdot n(p)) < 0 \\ R(l, v(p), n(p), \sigma, \rho)(l \cdot n(p)) & \\ & \text{otherwise} \end{cases} \quad (5)$$

FIG.5

FIG.6

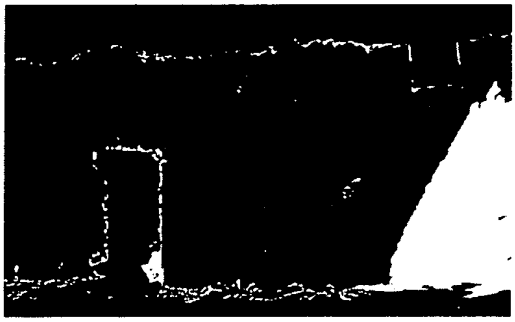

FIG.7

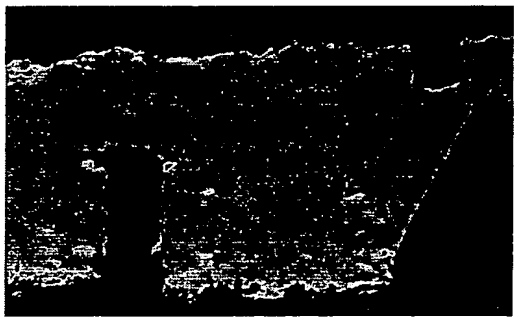

FIG.8

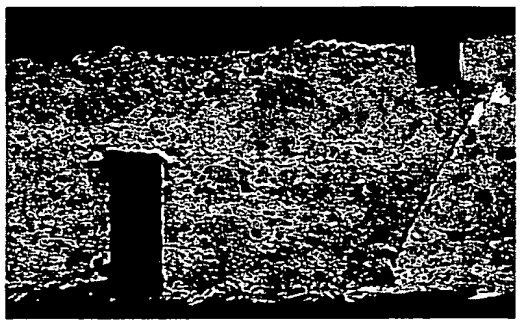

FIG.9

FIG.10

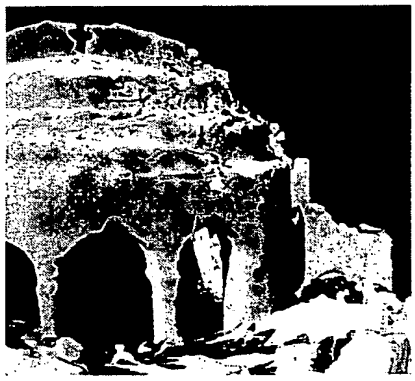

FIG.11

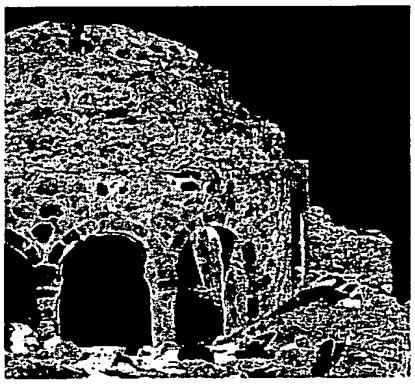

FIG.12

FIG.13A

FIG.13B